Removal Of Light And Heavy Organics By Ozone Processes

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Organics, whether unintentionally adsorbed onto the silicon wafer from cleanroom ambience or intentionally put onto the wafer during the semiconductor process steps, are known to severely impact gate oxide integrity for sub 180 nm device technologies.[1] The organics adsorbed onto the wafer surface cover a large range of compounds and are classified in two broad classes: heavy organics (photoresists and post-ash residue) and light organics (all other organics that are *not* heavy organics). The removal efficiency of ozone processes are dependent upon the type of organic being removed[2]; light organics are easily removed using ozonated DI water at room temperature[3] while heavy organics are stripped in a gas phase process at high temperatures.[4]

In this work, a novel method is presented to show the uniformity of light organic removal from the wafer surface by the dissolved ozone process. A bare silicon wafer was coated with a challenge organic (hexamethyl disilazane; HMDS) which was then removed by ozonated DI water. The resultant ozonated oxide was etched in HF to produce a contrast between the bare silicon surface and any HMDS remnant on the surface and scanned by AFM to visually locate such remnants (Figure 1). Contact angle measurements and AFM scans of the post process wafer showed a clean, organic free wafer surface with no HMDS islands.

In addition, results will be presented to show the removal of heavy organics from the wafer surface. Photoresist strip rates in an ozonated DI water immersion bath were very slow with the photoresist removal rate being limited by mass transport of ozone to the wafer surface.[5] Vapor phase ozone processes give significantly higher strip rates, in accordance with results obtained by other investigators.[4] Effect of various factors on stripping a DUV photoresist such as humidity, ozone concentration and temperature (Figure 2) will be shown and their role in the photoresist stripping mechanisms discussed.

References:

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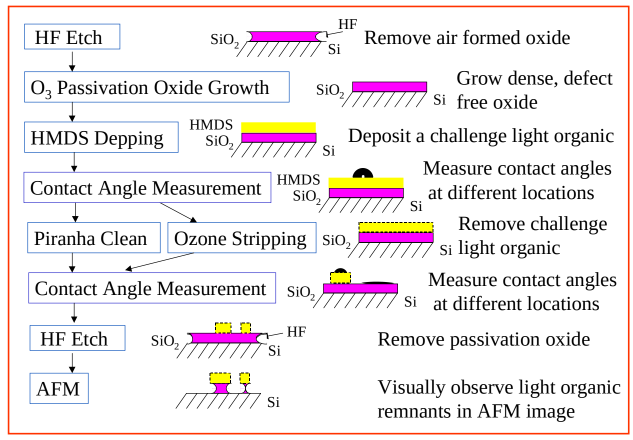

Figure 1. HMDS test plan showing the changes taking place at the Si surface corresponding to the various processing steps in the plan.

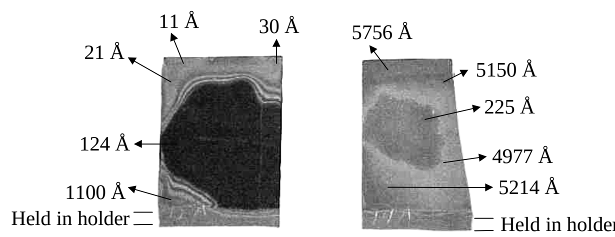

Figure 2. 7400Å thick hard baked DUV photoresist after stripping by an ozone process. The chiclet on the left was stripped by an ozone process at 60 °C while the one on the right was stripped by an ozone process at room temperature.